University of Waterloo
ECE 481: Digital Control Systems

Spring 2026

Lecture times, building and room number: Mondays and Wednesdays 5:30 PM to 6:50 PM, E7-4433.
Laboratory location: E2-3342.
Tutorial times, building and room number: To be determined.

Instructor: Alex Lovi, alovi@uwaterloo.ca
Office Hours: To be determined.

Lab Instructor: Sergio Reyes Livera, E2 3340, srlivera@uwaterloo.ca.

Course Description: This course covers the analysis and design of sampled-data and discrete-time control systems. Topics covered include modeling of dynamical systems (transfer functions and state-space) in continuous and discrete time; introductory non-linear analysis; digital control system design using emulation methods and pole-placement. The laboratory component will focus on system identification, control design, and control implementation of mechatronic systems.
Course Prerequisites: ECE 380/MTE 360/SYDE 352/SE 380, or equivalent.

Course Objectives: At the end of the course, students will be able to:

- Design and implement controllers to satisfy performance specifications in physical systems.
- Understand the effects of sampling rates on the performance of digital controllers.
- Discretize plants for direct discrete-time controller design, and discretize continuous control laws for microcontroller implementation.

Textbook: Course notes will be available on the course website. Additional references can be found in the library.

Evaluation:

25% Laboratory (Breakdown provided during first week).
25% Mid-term exam (Week of 22nd of June, 2026).
50% Final exam.

Tentative Topic List

1. **Introduction:** Motivation. Discrete-time control systems and sample-data control systems.
2. **Review:** BIBO stability, feedback stability, time-domain specifications: transient response and steady-state performance.
3. **Software:** MATLAB/Simulink. Introduction to system identification.
4. **Pole-placement for continuous-time systems**

5. **Discretization of continuous-time plants**
6. **Nonlinear systems:** State-space model, linearization.
7. **Linear discrete-time systems:** Difference equations, $\mathcal{Z}$-transforms, BIBO stability, feedback stability, frequency response.
8. **Control design in discrete-time:** Pole-placement in z-domain with performance specification.
9. **Advanced application topic**

Administrative Policy: University Policy

Mental Health: At the University of Waterloo, we are dedicated to supporting your mental and emotional well-being. Our Counseling Services offer confidential support, including individual counseling, workshops, and crisis intervention. If you're struggling, please reach out for help at 519-888-4096 or visit their website for more information.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offense, and to take responsibility for their actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities and disabling conditions: The University of Waterloo recognizes is obligations under the Ontario Human Rights Code to accommodate students with known or suspected disabilities and disabling conditions (e.g. medical conditions, injuries, impacts of trauma such as from violence or discrimination) to the point of undue hardship. To support this obligation, AccessAbility Services (AAS) collaborates with all academic departments and schools to facilitate academic accommodations for students with disabilities and disabling conditions without compromising the academic integrity of the curriculum. If you believe you may require academic accommodations (e.g., testing accommodations, classroom accommodations), register with AAS as early in the term as possible by completing the online application. Students already registered with AAS must activate their accommodations for each of their courses at the beginning of each term using AAS' online system. If you require assistance, contact AAS by phone (519-888-4567 ext. 35082), email (access@uwaterloo.ca) or in-person (Needles Hall North, 1st Floor, Room 1401).

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.